Endangered Marine Finfish: Neglected Resources or Beasts of Fiction?

By Gene R. Huntsman

ABSTRACT

As of this writing, of 1,321 taxa listed on the U.S. federal listing of threatened or endangered organisms, only six have marine or estuarine phases in their life history. None of the six are wholly oceanic. Indecision as to the applicability of the Endangered Species Act (ESA) to wholly oceanic species stems from at least two sources: (1) lack of consensus on population criteria designating special status, and (2) societal and scientific doubt as to whether wholly oceanic species can become endangered. A cursory examination of marine fishes of U.S. territorial waters by regional specialists suggests that at least 39 species are severely depleted and deserve closer examination of their population status to determine eligibility for protection under the ESA. Several regional groupings of the candidate species suggest ecosystem-wide impacts. Where fishing is suspected to be causing large-scale disruptions of fish abundance and fish community relationships, establishment of marine reserves might be a prudent management policy.

Despite more than 20 years of resource protection under the ESA and the listing of more than 1,321 terrestrial and freshwater organisms as threatened or endangered, not a single wholly oceanic marine finfish has been listed. The six listed marine fishes are all anadromous or estuarine during some part of their life. In this report I (1) discuss issues to be resolved in listing under the ESA of wholly oceanic marine fishes; (2) describe issues that differ when listing oceanic v nearshore, estuarine, and anadromous species; and (3) provide an inclusive list of the marine species already listed and those suggested for possible listing under the ESA.

Endangerment to species is an issue of both reality and legality. In reality, species may be threatened with extinction anywhere on Earth. Regarding legality, however, only the United States among North American nations establishes definitions of endangerment by law and prescribes recovery for endangered organisms. Thus, this discussion will focus on fishes in U.S. marine waters.

Issues

A substantial dichotomy characterizes the description and potential listing under the ESA of populations of finfish with marine affinities. All the species listed to date, and many proposed for listing, have intimate ties at some life history stage to estuarine or riverine habitats. No species that is wholly oceanic has been listed, although a few have been suggested. There are two reasons for this dichotomy:

(1) Estuaries and rivers are both far scarcer and far more susceptible to anthropogenic degradation and manipulation than are oceanic habitats. The list of filled wetlands, salinity alterations, dams, and channels hardly needs to be recalled here. Both habitat scarcity and alterations are liabilities to dependent fish populations.

(2) It is much easier for society to conceive of depletion and endangerment to a species limited to a nearshore habitat than to a species which, simplistically viewed, has access to apparently vast oceanic habitats. Nearshore species are more accessible to humans, and nearshore species' behavior is better known and predicted, so exploitation can be more effective. Further, documenting population declines of species that by virtue of their habitat are readily available for sampling and observation is much easier, though not necessarily easy. Conversely, endangerment for fishes of the open ocean is less easily conceived. For endangered coastal and anadromous marine finfish, depletion largely results from habitat modification and, sometimes,

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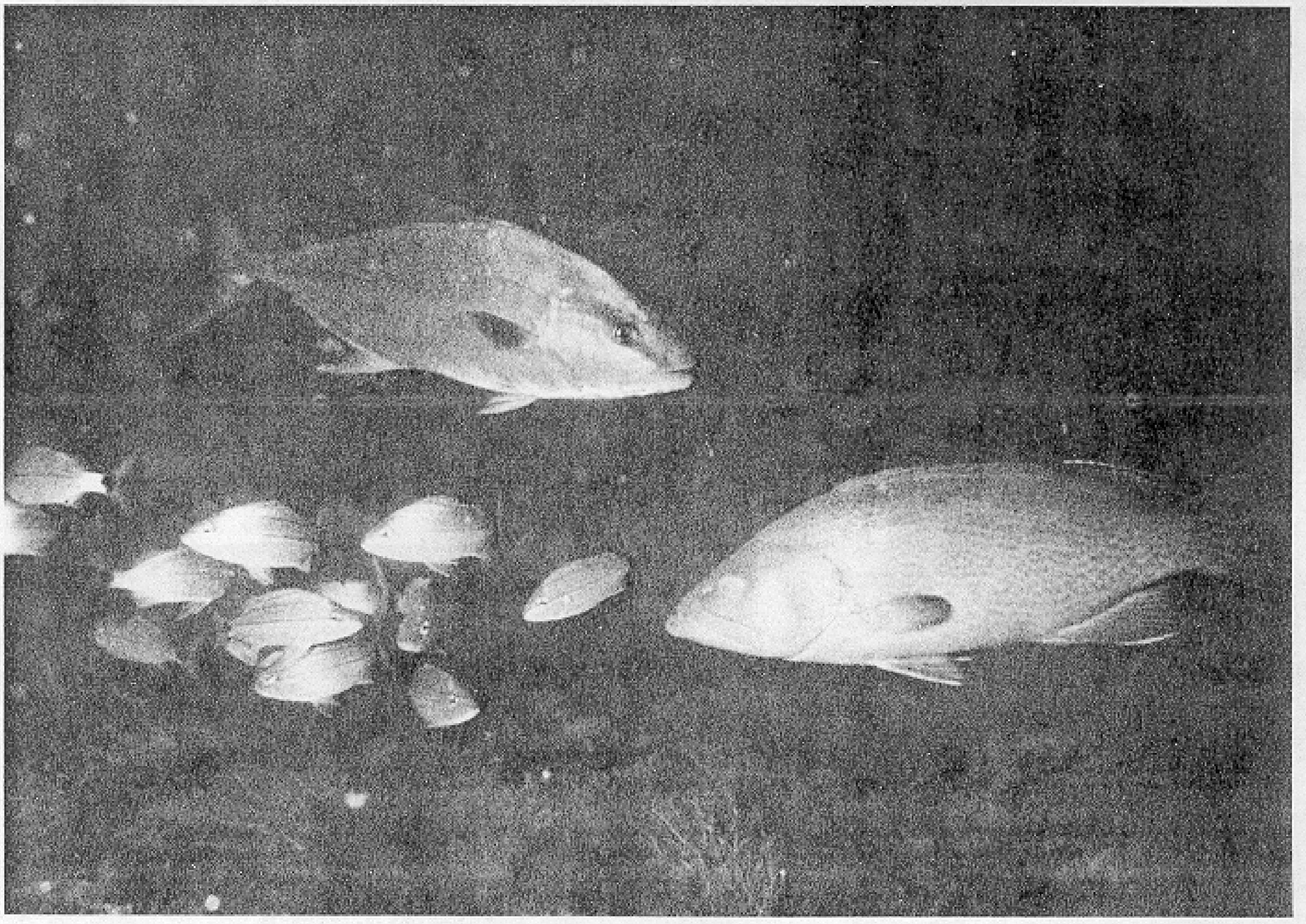
exploitation. But for wholly oceanic fish, possible endangerment is usually attributable to overexploitation. Fishing operations such as trawling, even in the open ocean, can modify the physical environment so it no longer supports certain species (Sainsbury 1987), or they can modify the biological community and establish new equilibria in which certain species can no longer thrive (Fogarty 1992). But even these modifications are reasonably categorized with overexploitation. Given greater uncertainty about the status of populations of wholly oceanic species and the suspicion that distant units of far-flung populations may supply eggs, larvae, or juvenile fishes to depleted units, many biologists are skeptical that endangerment is possible for truly marine species.

Implementing the ESA for wholly oceanic finfish has proceeded slowly for at least three reasons:

(1) First, while most population biologists studying marine finfish agree on the conceptual definitions of such population statuses as *endangered* (Mace et al. 1993) and the more prevalent *overfished*, the operational definitions of these terms remain the subjects of debate. Both the choice of the most appropriate population variable and the specific value for designating the population status of marine fishes are highly controversial (as for overfished) (Rosenberg 1993) or have received little attention (as for endangered, threatened). While endangered and overfished, as well as unexploited and extinct, are population levels on the same continuum, specifying the points at which to divide the continuum is difficult. Given that endangerment in the United States is a legal condition, the establishment of government promulgated conceptual and operational definitions of endangerment for oceanic marine fishes is required before the ESA can be applied. Until a definition is selected, protection under ESA for oceanic species will not occur.

Personnel most clearly charged with attaining a definition, the staff of the National Marine Fisheries Service (NMFS) Office of Protected Resources, apparently has been uncomfortable in specifying the criteria for endangerment themselves. Because of strong public and, consequently, congressional sentiment, protection of marine mammals and turtles has occupied most of the NMFS staff's limited resources. Marine fishes, which have not generated newsworthy problems have received far less attention. Population biologists, those most competent to



R. O. Parker Jr.

Marine fisheries reserves may help save declining southeastern grouper.

provide a definition, largely are assigned to guide harvest levels of healthy or somewhat depressed stocks, and appear reluctant to venture beyond their regular duties to an area some regard as the extremist fringe of fishery management. However, Thompson (1991) discusses several approaches to determining minimum viable populations. Until responsibility for providing definitions and criteria is fixed and accepted, we should not expect rapid progress toward application of the ESA to wholly marine fishes.

Progress is occurring in the search for definitions. First, Irma Lagomarsino of NMFS Southwest Regional Office (while on temporary assignment to the NMFS Office of Protected Resources) spoke about quantitative standards for threatened and endangered status at the AFS annual meeting in 1992. These standards, *which lack any formal institutional sanction*, are that a species is endangered if it is (1) in danger of extinction, (2) is ecologically extinct, (3) is below 5% of its original adult population size, or (4) is otherwise severely depleted throughout all or a significant portion of its range. A species is threatened if it is likely to enter one of the above states in the foreseeable future. The selection by Lagomarsino of a quantitative standard as one criterion admits to the continuum of population conditions described earlier. That standard approximately follows the establishment by several regional fishery management councils of quantitative criteria for overfishing that relate to the spawning stock biomass per recruit ratio (SBR) (Gabriel et al. 1989). For example, the South Atlantic Fishery Management Council has established that any of 72 species of reef fish with an SBR of less than 30% is overfished, while the Gulf of Mexico Council chose values of SBR of less than 20% to designate overfishing for the red snapper (*Lutjanus campechanus*). Establishing a single numerical criterion to be applied to many species might be misleading. For instance, the Atlantic menhaden (*Brevoortia tyrannus*) appears to sustain its population well at an SBR of only 7%–10% (Vaughan 1993), while mutton snapper (*Lutjanus analis*) may experience substantial population declines at an apparent SBR of about 50% (Huntsman et al. 1993). Improvements to the criteria offered by Lagomarsino would be specification of (1) whether the population abundances are to be described in numbers as for most mammals and birds, or in spawning biomass as is usual for fishes and (2) the level of precision necessary in estimates of status.

(2) A second reason for slow application of the ESA to marine fishes is the apprehension that its application would seriously reduce flexibility in managing fisheries for depleted species and associated fishes. Conceivably, major fisheries might be closed were an endangered species a by-catch of an abundant target species. Given the possibilities of substantial financial losses and public consternation, and the lack of definitions, standards, and a conceptual framework, NMFS understandably appears to have been cautious in applying the ESA in the open ocean.

(3) Beyond the ESA, numerous arrangements for protecting and restoring marine fish populations already exist. The Fishery Conservation and Management (Magnuson) Act as well as numerous interstate and international organizations all potentially offer protection to marine fishes. For the most part these organizations and arrangements have focused on species of greatest economic importance, while potentially endangered taxa usually were not, or are no longer, of much direct commercial or recreational importance.

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At least two questions must be addressed to establish a conceptual framework. First, can sufficient genetic and geographic isolation be maintained in an oceanic environment to render a taxon (species or less) vulnerable to endangerment? Both genetic research and empirical observation substantiate that genetic isolation can occur in the ocean. Lisa W. Seeb, in a presentation at the 1990 AFS annual meeting in Pittsburgh, Pennsylvania, described the nature of genetic diversity in the ocean and the need for its preservation. For instance, apparently depleted subpopulations of the Atlantic herring (*Clupea harengus*) have easily distinguished phenotypes (e.g., quality of the flesh as human food) that are believed to be genetically based (Gordon Waring, personal communication, 1990). Although we may not understand the mechanisms of genetic isolation in the oceans, it occurs. Preserving resulting genetic variants is an appropriate use of the ESA.

Second, the question central to establishing a conceptual framework for the ESA is whether a marine species can be listed as in jeopardy in one part of its range and not in another. Could a taxon be listed as threatened or endangered in U.S. waters if healthy populations appeared to reside in waters of another nation adjacent to the same oceanic body? At a finer scale, could a fish be listed in, for example, the Atlantic Ocean off the southeastern United States but not in the Gulf of Mexico? What level of interchange of larvae or adults would preclude listing of a taxon in a subunit of the ocean? An example of the geographic problem is provided by the warsaw grouper (*Epinephelus nigritus*), which is small (8–10 kg) and moderately abundant in the western Gulf of Mexico but severely depleted (SBR = 0.005–0.06) off the U.S. southeastern Atlantic states (Huntsman et al. 1992). In that region the species—which can exceed 200 kg—once functioned as the top resident predator of deep (>100 m) reefs. The number of warsaw grouper per reef was usually small (one or two), but most reefs had them. Now, warsaw grouper are absent from most reefs, and when found, their sizes are small (usually <10 kg). No knowledge exists of the exchange of adults or larvae between the Gulf of Mexico and the U.S. southeast. Should the warsaw grouper receive ESA protection in the Atlantic, where it apparently meets two of Lagomarsino's criteria for enjdangerment: (1) The species may be ecologically extinct, and (2) based on admittedly imprecise estimates of SBR, its "abundance" is extremely low? Or, must designation await research that establishes a separation of Atlantic and Gulf stocks—research that because of the low direct economic value of the animal may never occur and, because of the intrinsic rarity of warsaw grouper, is unlikely to be conclusive.

At the 1992 AFS annual meeting, Michael Bean, an attorney for the Environmental Defense Fund and a highly regarded expert on the ESA, gave his analysis of the NMFS interpretation of the definition of *species* found in the ESA. The ESA defines *species* as "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. The NMFS policy stated 20 November 1991 is that to be considered a "distinct population," and hence a species under the ESA, a population of Pacific salmon (1) must be substantially reproductively isolated from other conspecific population units, and (2) must represent an important component in the evolutionary legacy of the species. The second criterion would be met if the population contributed substantially to the ecological and genetic diversity of the species as a whole."

According to Bean, "NMFS fastened upon the word 'distinct' in the phrase 'distinct population segment' to conclude that geographic or reproductive isolation, by itself, was insufficient to render a population an appropriate entity for listing. In addition, it was necessary to find some other basis for concluding that the separate population was 'evolutionarily significant.' Populations inhabiting unique habitats, exhibiting unique behaviors, or otherwise expressing in some way special adaptations not routinely found in other populations of the same species would be deemed 'evolutionarily significant' and thus appropriate for listing. Others would not.

"On its face, the NMFS population policy applies only to Pacific salmon. Despite the agency's disclaimer of a wider application, it is hard to imagine that the policy will not influence both NMFS's and the Fish and Wildlife Service's attitudes toward listing populations of other marine and nonmarine species. The NMFS policy is clearly at odds with prior Fish and Wildlife Service practice. None of the population listings done by that agency has ever addressed the issue of evolutionary significance."

The warsaw grouper, by example, also raises the question of whether criteria other than abundance should be invoked when considering endangerment to marine fishes. Can a population age distribution that is radically altered from the unfished state signal endangerment? The most common manifestation of this problem is extraordinary loss of older fish from the population because of fishing. Shortened life spans because of fishing pressures can void protection against long-term environmental fluctuation provided to species by long life spans achieved through eons of evolution (Leaman and Beamish 1984). Another taxon exhibiting dramatic changes in population age distribution is the western Atlantic stock of Atlantic bluefin tuna (*Thunnus thynnus*). While bluefin tuna are far from extinct numerically, spokespersons for some environmental and recreational fishing groups believe that the drastic changes in age distribution of the species justify the legal status of endangered for the species (Safina 1993). The extraordinary economic value of bluefin tuna engenders pressures for legal and illegal fishing and exacerbates the vulnerability of the population.

Another needed determination is how to treat species that are apparently intrinsically rare, so rare that determination of their exact population status is, if not impossible, unaffordable. These species, exemplified by several Pacific rockfishes (*Sebastes spp.*) and the marbled grouper (*Epinephelus inermis*) (C. L. Smith, personal communication, 1992) are taken incidentally to fisheries for other species and conceivably could be placed in jeopardy without society's awareness.

Endangered, Threatened, and Special Concern U.S. Marine Fishes

Below are the marine, estuarine, and anadromous fishes inhabiting U.S. waters that are federally listed as threatened and endangered as well as those offered by knowledgeable observers as potential candidates for listing. The sources for the list include the official federal listing (FED) maintained by the Fish and Wildlife Service; the AFS listing in 1989 of fishes that are endangered, threatened, or of special concern (AFS 89) (Williams et al. 1989); a contract report to the NMFS Office of Protected Resources by L. Kaufmann in 1991 (LK); a list published by NMFS in the *Federal Register* on 11 June 1992 (NMFS); and species proposed by speakers at symposia on endangered marine finfish at the annual 1990 and 1992 AFS meetings (name AFS 1990; name AFS 1992).

This listing is inclusive to generate the maximum discussion of potentially listable species but is, of course, imperfect. Some of the 39 species (as well as scores of races of Pacific salmonids) may not actually be seriously threatened. On the other hand, some species are doubtless omitted that warrant consideration. For instance, the status of most sharks—animals of low fecundity and demonstrated high vulnerability to fishing—is unknown. The great white (*Carcharodon carcharias*) and lemon sharks (*Negaprion brevirostris*) are two species for which special concern has been expressed. I included in my list only those fishes for which sufficient knowledge existed for someone to make at least a crude estimate of population status. Information about some uncommon marine species is so scant that it precludes even an approximation of their condition. Further attempts to apply the ESA to marine fishes must identify and attempt to eliminate the worst gaps in our knowledge of scarce marine fishes.

Anadromous Species

chinook salmon (*Oncorhyncus tshawytscha*)
(Sacamento River, winter run, FED; Snake River, fall run, FED listing imminent).
sockeye salmon (*Oncorhyncus nerka*) FL.
(Snake River run, FED).

In addition, more than 214 river-specific stocks of anadromous stocks of salmonids on the U.S. Pacific drainage are believed to be at risk of extinction (Nehlsen AFS 1992).

Atlantic salmon (*Salmo salar*)
Extirpated in much of its original U.S. range. Five runs specific to Maine rivers are candidate species for federal listing.

Alabama shad (*Alosa alabamae*)
While anadromous runs of several *Alosa* species of American shad (*A. sapidissima*), alewife (*A. pseudoharengus*), hickory shad (*A. mediocris*), and blueback herring (*A. aestivalis*) appear to offer many perfect analogies to the state of Pacific coast salmonids, including the drastic depletion of many river specific runs, the evidence for strong genetic isolation among these runs is currently weak (Brown, AFS 1990). The Gulf of Mexico anadromous alosid, Alabama shad (*A. alabamae*), does appear to be genetically separable and extraordinarily reduced in abundance (Barkuloo et al. AFS 1992). Its candidacy for a jeopardy listing merits serious consideration.

Gulf sturgeon, (*Acipenser oxyrhyncus desotoi*)
(FED, LK)
Atlantic sturgeon, (*Acipenser o. oxyrhyncus*)
(AFS 89, NMFS)
shortnose sturgeon, (*Acipenser brevirostrum*)
(FED)

Catadromous, Estuarine, and Nearshore Species

delta smelt (*Hypomesus transpacificus*)
(FED; Herbold and Moyle, AFS 1992)
longfin smelt (*Spirinchus thaleichthyes*) (California population)
(FED, Herbold and Moyle AFS 1992)
mangrove rivulus (*Rivulus marmoratus*)
(Gilmore and Loftus, AFS 1990; Loftus et al., AFS 1992)
saltmarsh topminnow (*Fundulus jenkensii*)
(LK, NMFS)
key silverside (*Menidia conchorum*)
(LK, NMFS)
opossum pipefish (*Microphia brachyurus*)
(LK; NMFS; Gilmore and Loftus, AFS 1990; Loftus et al., AFS 1992)
striped croaker (*Bairdiella sanctaeluciae*)
(LK, NMFS)
totoaba (*Cynoscion macdonaldi*)
(FED but not found in U.S. waters)
river goby (*Awaous tajasica*)
(LK, NMFS)
oopu nakea (*Awaous stamineus*)
(AFS 1989)
bigmouth sleeper (*Gobiomorus dormitor*)
(Gilmore and Loftus, AFS 1990; Loftus et al., AFS 1992)
tidewater goby (*Eucyclogobious newberryi*)
(AFS 89; LK; NMFS; Herbold and Moyle, AFS 1992)
slashcheek goby (*Gobionellus pseudofasciatus*)
(LK, NMFS)
oopu alamoo, (*Lentipes concolor*)
(AFS 1989)
oopu nopili, (*Sicydium stimpsoni*)
(AFS 1989)

Primarily Oceanic Species

largetooth sawfish (*Pristis pristis*)
(NMFS)
Atlantic herring (some stocks) (*Clupea harengus*)
(Waring et al., AFS 1990)
haddock (some stocks) (*Melanogrammus aeglefinus*)
(Mayo and Serchuk, AFS 1990)
Acadian redfish (some stocks) (*Sebastes fasciatus*)
(Mayo and Serchuk, AFS 1990)
Various Pacific rockfishes (*Sebastes spp*)
(Seeb, AFS 1990) Existence of rare rockfishes that have slow growth, great maximum age and age at maturity, and may look like and co-occur with abundant species that are the targets of fisheries, in combination, signal need for closer examination of this group.
giant sea bass (*Stereolepis gigas*)

(Gregory, AFS 1990) Limited U.S. range in southern California. Recreational harvest totally prohibited. Incidental commercial catch allowed.

speckled hind (*Epinephelus drummondhayi*)
(Huntsman, AFS 1992)

warsaw grouper (*Epinephelus nigritus*)
(Burton and Huntsman, AFS 1990)

marbled grouper (*Epinephelus inermis*)
(Smith, AFS 1992)

jewfish (*Epinephelus itajara*)
(LK, NMFS, Gregory et al., AFS 1992) Harvest prohibited in waters of continental United States.

Nassau grouper (*Epinephelus striatus*)
(LK; NMFS; Sadovy, AFS 1992) Harvest prohibited in federal waters of United States and of Florida.

gulf grouper (*Mycteroperca jordani*)
(Gregory, AFS 1990)

broomtail grouper (*Mycteroperca xenarcha*)
(Gregory, AFS 1990) Both of the above *Mycteroperca* have limited U.S. distribution in southern California, and recreational harvest is prohibited.

notchfin schoolbass (*Parasphyraenops incisus*)
(LK, NMFS)

blue hamlet (*Hypoplectrus gemma*)
(LK, NMFS)

Gulf surgeonfish (*Acanthurus randalli*)
(LK, NMFS)

Gulf sierra (Monterey mackerel) (*Scomberomorus concolor*)
(LK, NMFS)

Atlantic bluefin tuna (*Thunnus thynnus*)
(Radonski et al., AFS 1990)

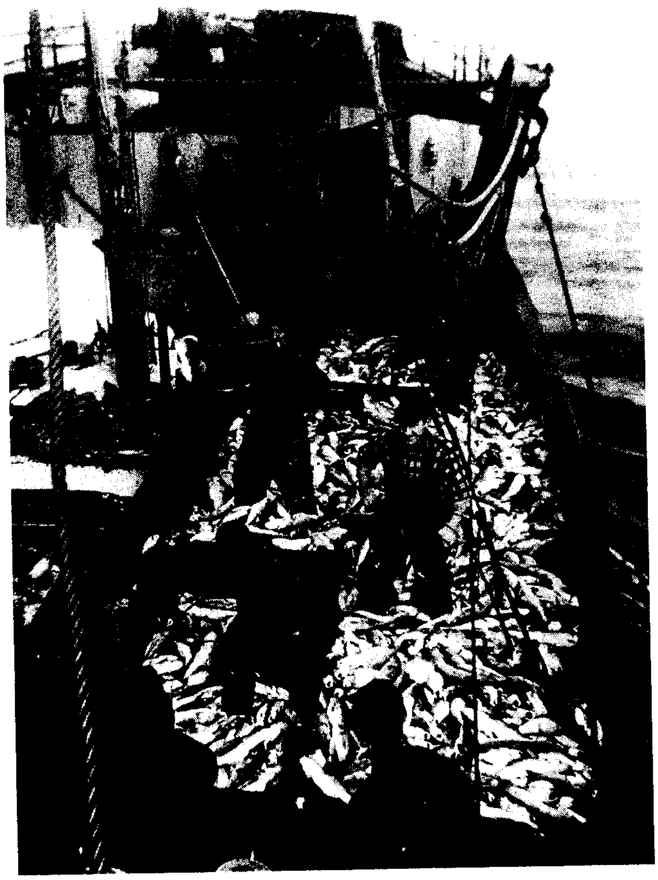
Conclusion

Even a cursory inspection of the list above reveals significant geographic groupings of species. Several species of the Sacramento-San Joaquin estuary are listed, as are groups from southern California rock reefs and kelp forests and from the reef systems of the southeastern U.S. continental shelf. These groupings are symptomatic of simultaneous harmful impacts on entire ecosytems. Water diversion in the Sacramento-San Joaquin system has drastically altered the San Francisco Bay estuary and its ability to sustain the species that evolved to survive natural conditions (Moyle 1992). Heavy fishing on the reefs of the southeast and the kelp forests of urban southwest California has depleted rarer members of these speciose communities to apparently perilous levels.

Systemwide effects should be addressed by systemwide responses. The plight of the few imperiled species for which we have information is symptomatic of the malaise affecting the entire ecological system. Species-by-species efforts to salvage depleted taxa are expensive and unlikely to succeed. Control of the root causes of jeopardy to piscine faunae can solve the observed problems as well as the many more we fail to perceive. Where depletion is environmentally engendered, solution of the problem may be easy to identify although difficult to implement. San Francisco Bay needs an altered and augmented regime of fresh water inflows. Providing that water, given political realities in California, will not be easy.

Where fishing is the suspected cause of jeopardy to species and alteration of fish communities, a solution of the problem is more difficult to identify. Because of historical practices and consequent public familiarity and acceptance, management devices such as species-specific bag and size limits, quotas, and seasons are preferred, and most often used, by fishery managers. These devices are insufficient to protect species in jeopardy. For such species even a total prohibition of capture is likely to be insufficient protection because they are often taken as a by-catch by fishers seeking more abundant species. Mortality of inadvertently captured and released fishes, especially some *Epinephelus* groupers from the deep (> 100 m) reefs of the U.S. southeast continental shelf can be 100%. Where release mortality is high, and the occurrence of a protected species as a by-catch is common, prohibition of capture and retention is functionless except for psychological purposes.

O. E. Sette Historical Collection



Once one of the most plentiful fish species on northeastern U.S. banks, haddock now are in serious trouble.

A management measure that obviates problems posed by traditional techniques and one that is gaining increasing acceptance internationally, is the fishery reserve (Roberts and Polunin 1991). Fishery reserves, known also as sanctuaries, harvest refugia, and production zones, are areas where fishing for all or certain categories of fishes is prohibited. Reserves are a system approach to fishery management that allows the reestablishment of age distributions and inter-and intra-specific relationships characteristic of unaltered communities. Given that life span, age at maturity, and age- and size-cued reproductive behavior, etc., are as much a product of evolution and as essential to the long-term survival of species as dentition and morphology, maintaining a portion of each species' population in an unaltered (relatively) state appears prudent. If it can be demonstrated eventually that the more familiar and politically acceptable management measures will provide needed protections to such complex and apparently fragile fishery systems as reefs, we can eliminate the reserves. While we are learning to manage complex systems, seeking insurance against management failure that fisheries reserves may provide also seems wise.

Marine reserves appear especially appropriate for management of the reefs of the southeastern United States. James Bohnsack (writing anonymously) presented a more detailed discussion of the applicability of reserves to reef management (Plan Development Team 1990). The reef systems are speciose (300–1,200 species) and little studied or understood. The life histories of even the most economically important fishes are only vaguely known. The age structure of most studied species has been altered drastically. Several species appear to be at risk and are subject to substantial mortality from by-catch in the mixed hook-and-line fisheries. Mortality of released fish can be very high. Further, the adults of

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most reef species appear to move little (usually zero to a few kilometers in a lifetime). Thus, reserves may be exceptionally appropriate to management and protection of reef systems and fauna. The Magnuson Act provides the framework for protecting individual species and fish communities. Appropriately applied, the Magnuson Act could eliminate the need for actions under the ESA. However, the Magnuson Act, as principally interpreted, focuses on species of direct economic value, does not carry the imperative for identification and protection of threatened species implicit in the ESA, and has been little used in the arena of rare fishes. Protection of Nassau grouper and jewfish by fishery management council action are noteworthy applications of the Magnuson Act to now-scarce species and are exceptions to the general use of the act.

Thought on the vulnerability of marine resources has undergone a rapid evolution. Barely two generations ago, skepticism existed that marine fish populations could be seriously affected by fishing (Huntsman 1948), despite obvious results to the contrary produced by W. F. Thompson (1937), Michael Graham (1943), and others. Gradually the idea became ordinary, and now it is almost requisite to believe that fishing can reduce marine fish stocks to well below the level of maximum productivity.

The belief that human activity, especially fishing, could reduce a population of a marine fish to the point where extinction is possible is following the same path. Skepticism that endangerment was even possible was prevalent five years ago. But five more years of the intense fishing that twentieth century humans can inflict, and five more years of observation and investigation of marine species that exist at barely measurable levels of abundance, have eroded the skepticism. Today, individuals and agencies are beginning to address forthrightly the issue of endangered marine finfish. To the early believers in endangerment, the change in opinion is a hollow victory, one bought only by increased evidence of misuse of fishery resources. According to U.S. Forest Service biologist Robert Szaro, speaking at the 1991 conference of Southeastern Association of Fish and Wildlife Agencies, "The time to preserve a species is while it is still common, not after it has become endangered." Unfortunately, we may have already forfeited the opportunity to effect timely protection of many marine fishes.

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